

# Impacts of Climate Change on Ocean Dynamics

Introduction	Climate Factors and Marine Species	Arctic Sea Ice Extent and Melt	Marine Heat Waves
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## Analyzing the Connection Between Ocean Dynamics and Climate Change

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### Topic 1: Climate Factors and Marine Species Shifts

- Which marine species appear to be most affected by sea level change?
- Which marine species have shown the most movement?
- Are there detectable changes to marine species migration patterns in the U.S.?

### Topic 2: Examining Sea Ice Extent and Melt Season

- Does the extent of Arctic sea ice impact its melt season?
- What sea ice ages have seen the lowest ice extent at the end of their melt seasons in September?
- How has the duration of Arctic sea ice melt seasons between March and September evolved over the years?

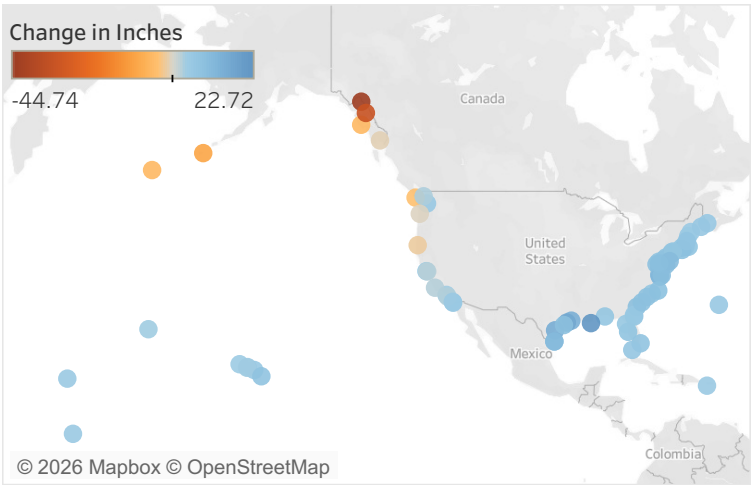
### Topic 3: Duration, Severity, and Regional Impact of Marine Heat Waves

- How have severe marine heat wave events changed over time between different U.S. coastal regions?
- Which marine protected areas experienced the most intense marine heat wave impacts between 2018 and 2023?
- How has the duration of marine heat wave events evolved over time, and which severity levels are most dominant across regions?

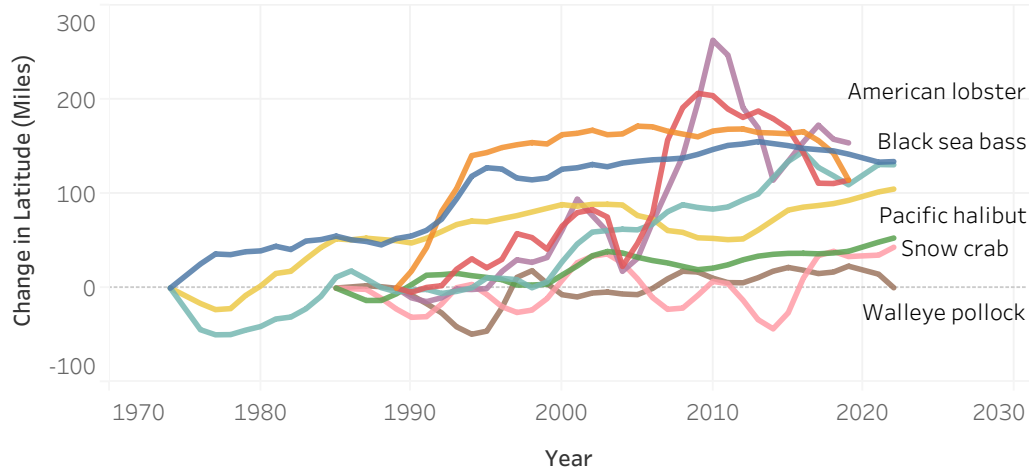
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Sea Level Change from 1960-2023



Change in Latitude by Species



Species Migration Patterns in the U.S. in 1992

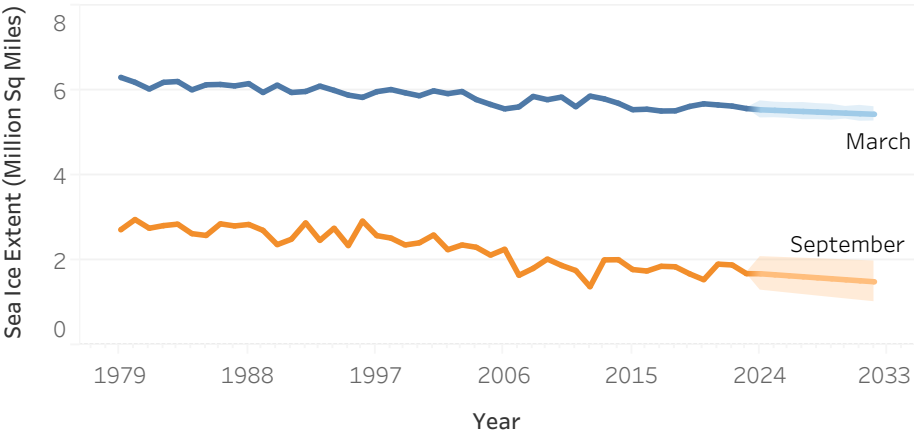


- Marine Species
- American lobster
  - Atlantic croaker
  - Banded drum
  - Black sea bass
  - Pacific halibut
  - Red hake
  - Smooth butterfly ray
  - Snow crab
  - Walleye pollock

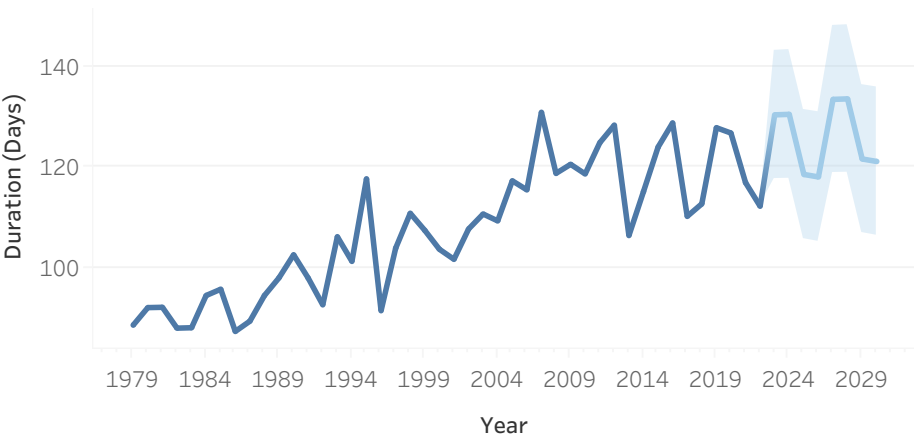
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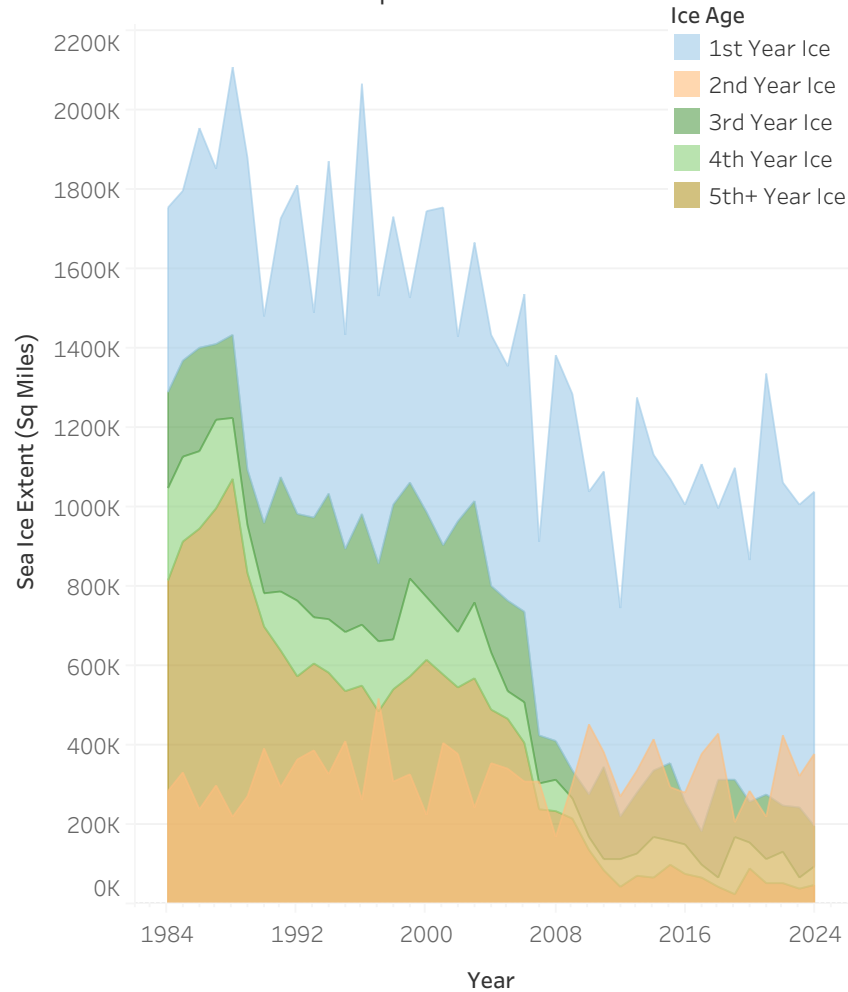
Arctic Ice Extent Monthly Average



Arctic Ice Melt Season Duration



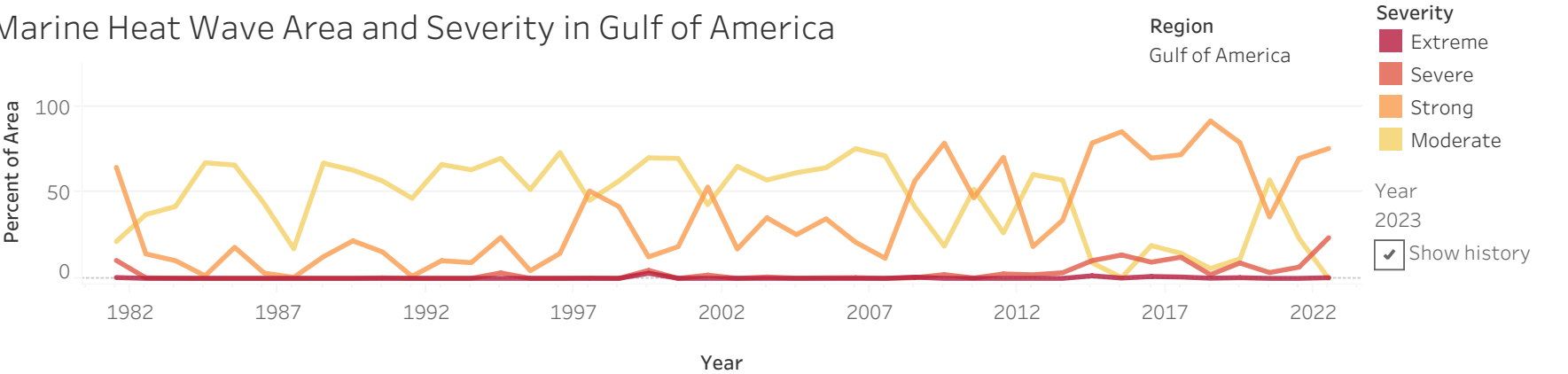
Arctic Ice Extent in September



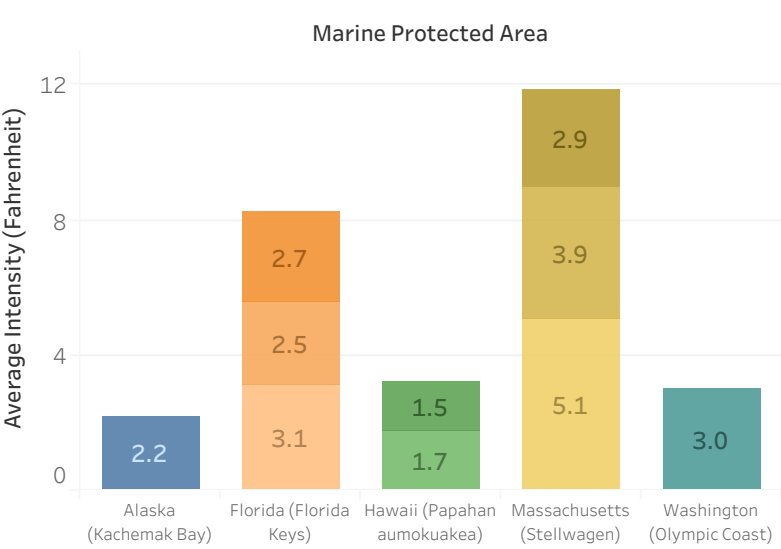
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Marine Heat Wave Area and Severity in Gulf of America



Change in Heat Wave Intensity in 2023



Heat Wave Duration in Washington (Olympic Coast)

